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13. ABSTRACT (Maximum 200 words)

This report summarizes scientific progress on "Basic Research in Electronics" which has been conducted under the auspices of the DoD Joint Services Electronics Program during the period 15 May 1992 - 31 July 1995. Progress on five solid-state, two information electronics, and two electromagnetic projects is described.

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FINAL REPORT ON ELECTRONICS RESEARCH AT THE UNIVERSITY OF TEXAS AT AUSTIN

NO. 52

For the period MAY 15, 1992 through JULY 31, 1995

JOINT SERVICES ELECTRONICS PROGRAM

Research Contract AFOSR F49620-92-C-0027

Submitted by Edward J. Powers

on behalf of the Faculty and Staff

of the Electronics Research Center

September 30, 1995

ELECTRONICS RESEARCH CENTER

Bureau of Engineering Research
The University of Texas at Austin
Austin, Texas 78712-1084

FINAL REPORT: JOINT SERVICES ELECTRONICS PROGRAM
CONTRACT AFOSR F49620-92-C-0027
The University of Texas at Austin

OVERVIEW

Research carried out under the auspices of this contract consisted of five research units in Solid State Electronics, two in Electromagnetics, and two in Information Electronics.

In Solid State Electronics the objective is to develop new materials and devices for electronic and photonic applications, based on an enhanced underlying knowledge of those materials and devices. Techniques have been developed for MBE regrowth on wafers removed from the system for photolithographic processing, and then applied to the fabrication of advanced vertical-cavity surface-emitting laser (VCSEL) structures. Building on previous work on low-temperature grown AlGaAs, the semi-insulating AlGaAs material has been patterned for current funneling and also as an etch-back layer to provide a GaAs shadow mask for selective growth and buried void structures. Oxidation of AlGaAs layers has been used to provide insulated regions in VCSEL structures having threshold currents of 225 μA. MBE growth of distributed Bragg reflectors has been utilized to make multiple-wavelength mirrors which exhibit great promise for photodiodes providing detection in multiple windows for multiplexing applications. Femtosecond-laser-induced second harmonic generation has been demonstrated to provide a quantitative diagnostic of angstrom-scale microroughness at the $Si(100)/SiO_2$ interface. Models for hot electron effects, avalanche mechanisms, and surface effects have been developed in support of the research previously described.

In electromagnetics, new extremely accurate and numerically efficient models of coplanar waveguide millimeterwave phase shifters, both voltage and optically controlled, have been developed. Furthermore, extremely high voltage quantum well diodes based on a depletion-edge modulated resonant tunneling diode have been characterized. Time-frequency space has been shown to be an attractive feature space for identifying target characteristics. Specifically, time-frequency information has been obtained using wavelet transforms, and most recently superresolution techniques. Such techniques appear to be excellent tools for understanding scattering phenomenology from computed or experimentally measured data.

In Information Electronics, work in multisensor signal processing involved the development of algorithms for analyzing signals from multiple sensors and multiple views. Accomplishments include a new methodology for an automatic interpretation system using multiple sensors, a new algorithm for detecting and interpreting linear features of a real scene as imaged by a single camera, and current development of an object recognition system which utilizes the Adaptive Resonance Theory (ART)-based ART-2 artificial neural network. In other work

involving applications of higher-order statistical signal processing and applications to nonlinear system identification, accomplishments include: the ability to model third-order (i.e., cubic) nonlinear systems and phenomena subject to nonGaussian random excitation, development of sparse third-order Volterra models with attendant savings in raw data, and new approaches to quantify and mitigate nonlinear distortion in telecommunication channels.

PRINCIPAL INVESTIGATORS

Professor Jake K. Aggarwal

Professor Joe C. Campbell

Professor Dennis G. Deppe

Professor Michael C. Downer

Professor Hao Ling

Professor Christine M. Maziar

Professor Dean P. Neikirk

Professor Edward J. Powers

Professor Ben G. Streetman

JSEP Supported Ph.D. Students

Choo, Heung Ro, Ph.D., "Rapid Scan Femtosecond Ellipsometry and its application to Optical Surface Diagnostics and Ultrafast Carrier Dynamics in Semiconductors," December 1992 (Downer)

Kim, Hyeongdong, Ph.D., "Interaction of Microwave Signal with an Arcjet Plasma Plume," May 1992 (Ling)

Kutchibhotla, Ravi, Ph.D., "New Phtodetectors for Optical Communications: Physics, Fabrication, and Characterization," December 1992 (Campbell)

Moore, John, Ph.D., Boundary integral solution to the electromagnetic scattering from coated surfaces containing edges, gaps and periodic gratings," December 1992 (Ling)

Oh, W.T., Ph.D., "Application of Higher-Order Statistics to Time Delay Estimation for Passive Sonar Systems," May 1992 (Powers)

Rogers, Thomas, J, Ph.D., "MBE Grown Microcavities for Optoelectonic Devices", December 1992 (Streetman)

Lebègue, Xavier, Ph.D., "Automated Modeling of Structured 3-D Scenes Using a Mobile Robot," December 1993 (Aggarwal)

Lei, Chun, Ph.D., "Spontaneous Emission in Semiconductor Microcavities and its Role in Vertical Cavity Surface Emitting Lasers, May 1993 (Deppe)

Sabata, Bikash, Ph.D., "Feature Correspondence and Motion Estimation from a Sequency of Range Images, August 1993 (Aggarwal)

Sadra, Kayvan, Ph.D., "Lateral Modulation - Doped Diodes", August 1993 (Streetman)

Samani, Darioush, Ph.D., "Time Domain Analysis of Adaptive Polynomial Filters with General Random Input and with Applications to Nonlinear Physical Systems, May 1993 (Powers)

Tseng, Ching-Hsiang, Ph.D., "Advanced Nonlinear System Identification Techniques and Their Application to Engineering Problems, August 1993 (Powers)

Wang, Xiaoyi, Ph.D., Hydro- and electro-dynamics of solid targets under intense femtosecond laser excitation, September 1993 (Downer)

Ahn, H, Ph.D., "Femtosecond Dynamics of Condensed Matter Under Planetary Interior Conditions, May 1994 (Downer)

Chowdhury, Andalib Ahmed, Ph.D., "Modeling of Superlattice Surface States, December 1994 (Maziar)

Gullapalli, Kiran Kumar, Ph.D., "Heterostructure Device Simulation Using the Wigner Function, August 1994 (Neikirk)

Huffaker, Diana Lynn, Ph.D., "Vertical Cavity Devices Based on Buried Native-Oxide Layers," December 1994 (Deppe)

Islam, Saiful, Ph.D., "Modeling and Experimental Studies of Schottky-Contacted Coplanar Waveguide Transmission Lines on Semiconductor Substrates", August 1994 (Neikirk)

Reddy, Vijay, Ph.D., "Characterization of High Frequency Oscillators and Varactor Diodes Grown by Molecular Beam Epitaxy, May 1994 (Neikirk)

Im, Sungbin, Ph.D., "Frequency Domain Volterra Approach to Nonlinear Systems, December 1994 (Powers)

Shih, Y-C, Ph.D., "Superlattice Quantum Well Structure for Short-Wavelength Light-Emitting Device Applications, December 1994 (Streetman)

Shaheed, M. Reaz, Ph.D., "Modeling and Simulation of Si and SiGe-Base Bipolar Transistors Operating at a Wide Range of Temperatures, May 1995 (Maziar)

Srinivasan, Anand, Ph.D., "Growth and Characterization of Low-Temperature Grown GaAs and Resonant Cavity Structures, May 1995 (Streetman)

Tong, Abraham Shen, Ph.D., "The Monolithing Integration of Indium Allow Heterojunction Bipolar Transistors and Light Emitting Diodes, December 1995, (Maziar)

JSEP Supported MS Students

Srinivasan, Anand, M.S., "Molecular Beam Epitaxy of Low Temperature Gallium Arsenide", May 1992 (Streetman)

Wei, Guo, M.S., "Femtosecond Ellipsometric Analysis of Semiconductor Epilayers", May 1992 (Downer)

Anselm, Alex, M.S., "A Small Scale Molecular Beam Epitaxy Machine for the Growth of III-V Semiconductors Using Novel Precursors", December 1993 (Streetman)

Bhalla, Rajan, M.S., "ISAR image formation using bistatic data from the shooting and bouncing ray technique," May 1993 (Ling)

Gaul, Erhard W., M.S., "Generation, Stabilization and Amplification of Ultra-Short Pulses", December 1993 (Downer)

Klimkowski, Kenneth, M.S., "Two-dimensional electromagnetic scattering calculations by the moment method on an iPSC/860 parallel computer", May 1993 (Ling)

Rashed, Md. Mahbub Bin, M.S., "Development of a Particle Simulator for the Study of Electronics Emitted from Laser Irradiated Metal Semiconductor Surfaces", August 1993 (Maziar)

Camarena, Jose, M.S., "Sensitivity Analysis of Xpatch-based Range Profile Simulations Subjected to Model Uncertainties", August 1994 (Ling)

Deng, Honyu, M.S., "Temperature Dependence of Transverse Lasing Mode in Vertical Cavity Surface Emitting Lasers", October 1994 (Deppe)

Frey, Alexander, M.S., "Repetition rate synchronization of a colliding-pulse mode-locked laser with an external oscillator", December 1994 (Downer)

Hansing, Chad, M.S., "Molecular-Beam Epitaxial Growth and Fabrication of Vertical-Cavity Surface-Emitting Laser Diodes", December 1994 (Streetman)

Regarajan, Rajesh, M.S., "Growth of Compound Semiconductors Using Single Source Precursors and Conventional MBE Techniques", August 1994 (Streetman)

Turner, Nelson C., M.S., "Dual beam detection of frequency shifted ultrashort laser pulses", December 1994 (Downer)

Park, In-Seung, M.S., "Design of Equalizers for Nonlinear Digital Communication Systems Using Volterra Filtering Techniques", December 1994 (Powers)

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